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Growth Rate Measurement of Scirpus Grossus Plant as Preliminary Step to Apply the Plant in Wastewater Treatment Using Reedbed System

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Abstract

Growth rate measurement of *Scirpus grossus* plant is conducted to know the growth characteristic. By knowing the growth characteristic of plant, it can be decided the exact time of the fastest growth of plant. Growth rate of plant can be measured by physical parameters such as stem height, number of leafes, leafes lenght, root lenght, wet weight and dry weight of plant. The aim of this study is to observe the growth characteristics of *Scirpus grossus* plant, which is need to apply the plant in wastewater treatment using reedbed system. By knowing the growth characteristics of plant, will be choose the exact age the plant that is match to be used in the experiment. Besides, it also can be used as a compartment physical indicator that shows the abnormality of *Scirpus grossus* plant which is exposing to wastewater. The steps conducted in this study are propagation plant to get second generation of plant which is observed its growth rate on stem height, leafes height, and number of leafes, root height, wet weight and dry weight.

Keywords: Growth rate; Leafes; Plant; Root; Scirpus grossus; Treatment; Wastewater

Introduction

Background of study

Growth rate is a measure of velocity of growth that can be used to draw the growth characteristic of a species. The measurement of growth rate can be conducted by using physical parameters such as plant height, root length, stem length, leafes length, leafes weight, leafes number, seed number, fruit number or any other parameters that can be observed visually. By knowing the growth characteristics of plant, can be decided the time that plant growth fastest and the age of plant that can be used in reedbed system to treat wastewater.

Objectives and advantage of study

The objectives of study are:

1. To determine the growth characteristics of *Scirpus grossus* plant (rumput mensiang).

2. To determine biomass ratio of *Scirpus grossus* plant (wet and dry weight).

3. To determine the time of fastest growth of *Scirpus grossus* plant.

The advantage of study is:

To get result that can be used to wastewater treat by using *Scirpus grossus* plant in reedbed system.

Literature Study

Wet and dry weight measurement

Wet weight and dry weight measurement is useful to determine plat biomass. The result will give information about plant number that is need to uptake pollutant from contaminated area that will remediate or by the other word is useful to *up scaling* from data from laboratory experiment [1].

Reedbed system

Reed bed is a technology for wastewater treatment and microbial activation process that can stimulate natural decomposition of pollutant in a special condition. This kind of treatment of reed bed system is possible for several plants that grow in wetland such as grasses. This kind of plant can move oxygen from atmosphere to its rhizosphere to increase the number and the diversity of microorganisms in its rhizosphere [2]. Reed bed basicly is a sewer that is cover with impermeable membrane, fill with gravel media which is planted with macrophyte such as grasses, bush and use to wastewater treatment, blackwater eventhoght greywater, that flow into root zone.

Treating mechanisms in reedbed system

In general, reedbed system is treating wastewater form primary treatment effluent to reduce suspended or floating solid from wastewater. Usually reedbed is designed to 5 to 7 days, which is time detention will give change to settle and filtrate suspended solid, nitrification/de-nitrification process, fixation in substrate, organic matter degradation and nutrient removal by microorganisms and plant uptake. Generally, time detention is arranged by area and height of reedbed. Beside, dead pathogen organisms inside the reedbed can be happened as a result of micro-organisms activity on gravel surface or root plant. Limitation of this reedbed system are long time detention and the availability of aerobic and anaerobic zone, but the quality of treated water will be increase by the increasing of time detention.

Reedbed design

Reed bed is better design with time detention of 5-7 day and height of 300-1000 m. The height and weight ratio are 3:1 and 1:1. If using circular reedbed, is suggested to use baffle in the middle and in inlet and outlet zone to avoid short-circuiting from wastewater in reed bed and cause decreasing the ability of treating. Generally, media is used in reedbed system is gravel with diameter of 10-20 mm. Wastewater enter the reedbed by inlet pipe which is placed higher than outlet due to dispersion of wastewater inside the gravel medium.

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Factors influence uptake mechanisms of plant

Factors influence in phytoremediation mechanisms are plant species, rhizosphere microorganisms, and medium plant characteristics [3-6]. Several plant species show success in pollutant uptake. They have ability to uptake and accumulate metals that important to its growth (Fe, Mn, Zn, Cu, Mg, Mo and Ni) and also to uptake metals that unknown its biological fuction (Cd, Cr, Pb, Co, Ag, Se, Hg) after it is extracted from soil or water by phyto-extraction process [7].

Scirpus grossus

Scirpus grossus is used in this study because this species is potential as hyper-accumulators [8]. It has fibrous root with white to brown color, triangle and solid stem, leaf length 2 m or more with 10 mm of thickness [9]. This plant is perennial aquatic plant with common name of *giant bulrush*, *greater club-rush* and *rumput menderong* (Malaysia), *mensiang*, and *walingi* (Indonesia). This plant is nature from South East Asia, and distribute to Australia, Borneo, Bhutan, Kamboja, Cina, Indonesia, India, Indocina, Laos, Malaysia, Myanmar, Pakistan, Filipina, Srilanka, Thailand, Turki and Vietnam [10]. This species is widely used to treat domestic wastewater in phytoremediation technology or wetland [11-13]. This plant can gave effect in water quality by increasing evapotranspiration mechanisms. According Ebrahimpour and Idris, *Scirpus grossus* can uptake metals with the highest concentration in root zone, stem and leaf compare with four other aquatic species which are observed [14-20]. Figure 1 show *Scirpus grossus* plant.

Methodology

Materials and instruments

Materials and instruments are used in this study:

1. Crate to acclimatization of plants and to propagation of plants.
2. Gravel and sand as growth media of plant.
3. *Scirpus grossus* plant.
4. Tap water.
5. Length and weight measure instrument.

Plant acclimatization

Scirpus grossus is taken from its nature habitat (wetland: swam, river, or water area), it is replanted inside the tank that filled with gravel and sand media and flow with water which will be used to dilute wastewater. The plant is placed in tank until the second generation (seed) growth and it is observed its physical parameters in mean period and in certain age. Plants with the same height and same age will be used in the experiment, and hopefully the initial condition will be same [21-26].

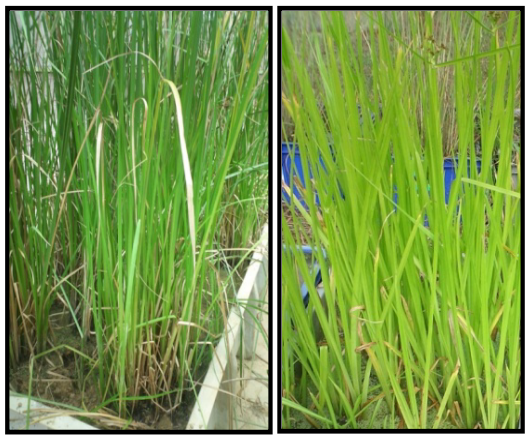

Figure 1: *Scirpusgrossus* plant.

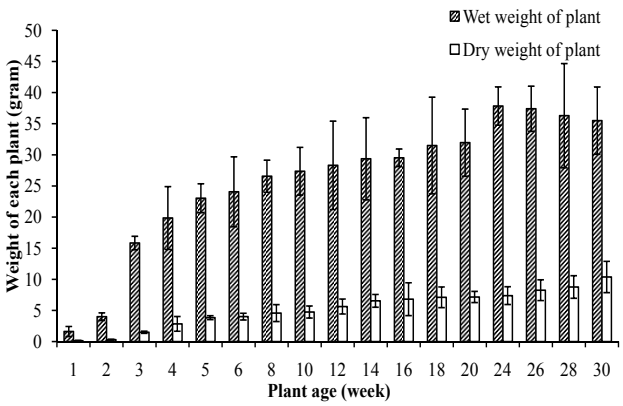

Figure 2: Wet weight and dry weight of plant during propagation.

Wet weight and dry weight measurement

To get the plant biomass data, the measurement of wet weight and dry weight of plant is conducted. Firstly, plant is taken from the planted medium and clean up with soft tissue paper to reduce the water and sand that is attached in plant surface [27-30]. Next, wet weight is measured promptly because plant contains much water and it can be lost very quickly. To measure dry weight, plant sample is placed to oven with temperature of 105°C in 2 hours minimum. After drying, plant is cooling in dry environment by placing inside the decicator within 1 hour and then balancing with analytical balance after cool [31-35].

Result and Discussion

Propagation and acclimatization of plant

Plant propagation is conducted in the early step of study, inside the tank or container fill with water contain with liquid fertilizer to get optimum condition for its growth. During propagation of plant, physical parameters were measured to determine plant growth characteristics in normal condition [36-40].

Scirpus grossus plant biomass measurement

The seed of *Scirpus grossus* grow within one month. This seeds after that is separated and moved to tank fill with water media which will use in the next study without fertilizer added. In this step, wet and dry measurement is conducted to determine water concentration and plant biomass. Wet and dry weight was measured since 1 one week of planted to 30 weeks (Figure 2). The result show increasing in wet weight since first week to week-24 and start decreasing the week after. Dry weight of plant also shows increasing tren since week-1 to the end of observation (week-30) (Figure 2). Decreasing trend of wet weight and increasing of dry weight was observed, it show that water concentration inside of plant tissue decrease after week-24, even though its dry weight still increasing (Figure 3). It shows that water content in plant tissue is around 90% in early week to week-3. After that, on week-4 to week-8, the water content is decrease to 80%, and then reaches 70% on week-9 to the end of observation time (week-30) [41-46]. This show decreasing in water content during the addition of plant age, even though dry

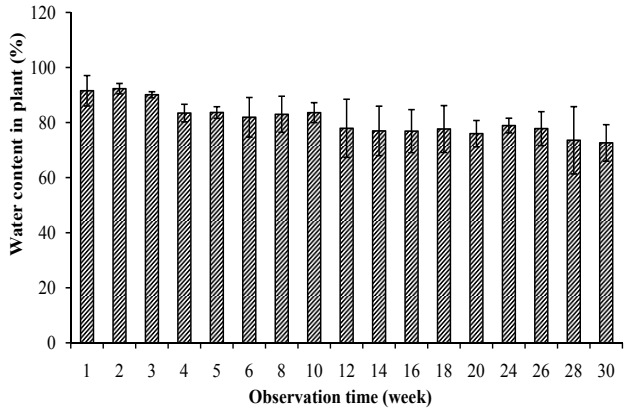

Figure 3: Water content in plant.

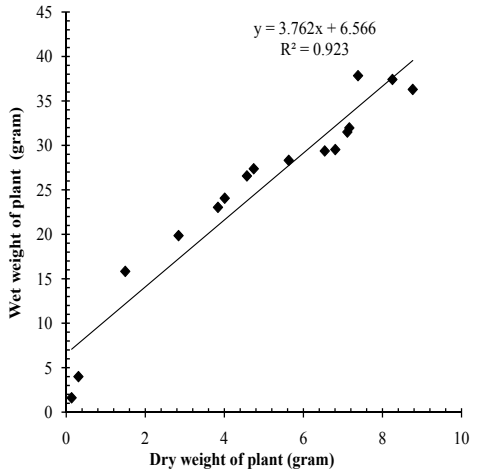

Figure 4: Wet weight and dry weight ratio.

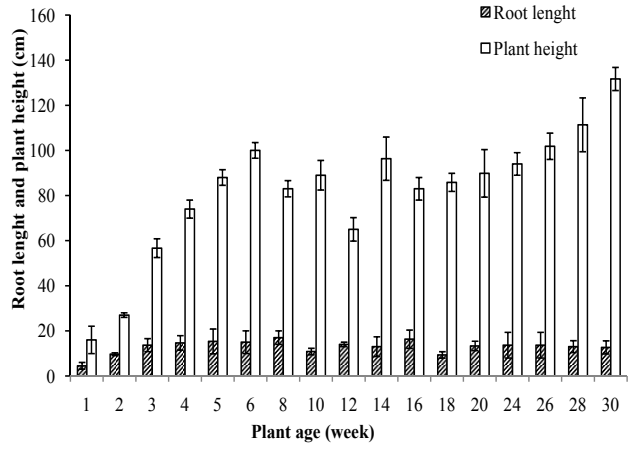

Figure 5: Root length and plant height during propagation time.

biomass of plant is still increase. The result of wet and dry weight measurement was draw the correlation and it is shown in Figure 4. The correlation formula is y=0.245x-1.233 (R^2=0.9238). This biomass plant data can be used as scale up fit toxicity study result to pilot scale to determine the ability of *Scirpus grossus* in contaminant uptake. The result of root length and plant height measurement is shown in Figure 5. It is shown that root length increasing on week-2, and after that the root length is same to the end of observation. For plant height, the result shows increasing during the observation.

Conclusion

Based on the experiment of propagation and physical parameters measurement of *Scirpus grossus* plant, these are some result:

1. Wet weight and dry weight of plant is observed and water contain inside the plant can be determined which is start on 90% and decreasing to 70% in the day-30.

2. Wet weight and dry weight of plant is needed to determine biomass of plant to uptake pollutant and wastewater treat. So that, the result of wet and dry weight observation can be used to design treatment to contaminated water in an area.

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